The effect of sex, age and performance level on pacing of Ironman triathletes

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Abstract: The aim of the present study was to examine the effect of sex, age and performance level on pacing of Ironman triathletes. Split times (i.e. swimming, cycling, and running) and overall race times of 343,345 athletes competing between 2002 and 2015 in 253 different Ironman triathlon races were analyzed. Participants were classified into nine performance groups according to their overall race time. Times in swimming, cycling, running and transition were expressed as percentage of the overall race time. Women spent relatively less time (%) in swimming, running and transition time, and more time (%) in cycling than men ($p < 0.001$). The fastest performance group was relatively faster in running (34.8 ± 1.4 versus 40.3 ± 3.0%, η= 0.098) and transition time (0.9 ± 0.3 versus 2.2 ± 0.6%, η= 0.178), and relatively slower in swimming (10.2 ± 0.8 versus 9.8 ± 1.5%, η= 0.018) and cycling (54.1 ± 1.4 versus 47.8 ± 2.8%, η= 0.138) than the slowest performance group ($p < 0.001$). The younger age groups were relatively faster in swimming, running and transition time, but relatively slower in cycling. In summary, the fastest Ironman triathletes were the relatively fastest in running and transition times. Thus, race tactics in an Ironman triathlon should focus on saving energy during swimming and cycling for the running split.

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The effect of sex, age and performance level on pacing of Ironman triathletes

Running head: **Pacing in Ironman triathlon**

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Abstract

The aim of the present study was to examine the effect of sex, age and performance level on pacing of Ironman triathletes. Split times (*i.e.* swimming, cycling, and running) and overall race times of 343,345 athletes competing between 2002 and 2015 in 253 different Ironman triathlon races were analyzed. Participants were classified into nine performance groups according to their overall race time. Times in swimming, cycling, running and transition were expressed as percentage of the overall race time. Women spent relatively less time (%) in swimming (10.13±1.35% *versus* 10.26±1.38%, Cohen's d=-0.10), running (37.53±3.01% *versus* 38.01±3.34%, d=-0.15) and transition time (1.79±0.61% *versus* 1.84±0.65%, d=-0.08), and more time (%) in cycling (50.55±2.83% *versus* 49.88±3.05%, d=0.23) than men ($p<0.001$). The slowest performance group was relatively faster in swimming (9.77±1.52% *versus* 10.20±0.83%, η^2=0.018) and cycling (47.77±2.83% *versus* 54.08±1.44%, η^2=0.138), and relatively slower in running (40.25±3.03 *versus* 34.81±1.42%, η^2=0.098) and transition time (2.21±0.57% *versus* 0.91±0.26%, η^2=0.178) than the fastest performance group. The younger age groups were relatively faster in swimming, running and transition time, but relatively slower in cycling. In summary, the fastest Ironman triathletes were the relatively fastest in running and transition times whereas the slowest athletes were the relatively fastest in swimming and cycling. For practical applications, race tactics in an Ironman triathlon should focus on saving energy during swimming and cycling for the running split at the end of the race.

Key Words: swimming; cycling; running; transition time; ultra-endurance

Introduction

Participation in ultra-endurance sports has increased during the last years as documented by studies on ultra-marathon (Knechtle, & Nikolaidis, 2017; Hoffman, & Krouse, 2018) and open-water swimming (Knechtle et al., 2017; Nikolaidis, de Sousa, & Knechtle, 2018). One of the most popular ultra-endurance sports is triathlon, which includes three different locomotion modes (swimming, cycling and running).

Ironman triathlon (*i.e.* 3.8 km swimming, 180 km cycling, and 42.195 km running) is of high popularity where both the number of races and athletes increases annually (Dähler, Rüst, Rosemann, Lepers, & Knechtle, 2014). In the Ironman World Championship 'Ironman Hawaii', both elite (Gallmann, Knechtle, Rüst, Rosemann, & Lepers, 2014) and age group athletes (Lepers, Rüst, Stapley, & Knechtle, 2013) improved performance in the last decades. Performance in triathlon depends on different factors including somatotype, physiological capacity, technical proficiency and pacing strategy (Ofoghi, Zeleznikow, Macmahon, Rehula, & Dwyer, 2016; Wu, Peiffer, Brisswalter, Nosaka, & Abbiss, 2014). To finish an Ironman triathlon, it is essential to distribute effort optimally throughout the race. Pacing is the strategy by which effort is managed across an exercise bout in relation to a specific goal and in the knowledge of the likely demands of the task (Edwards & Polman, 2012).

Generally, there are six different pacing strategies (Abbiss & Laursen, 2008): negative pacing (*i.e.* increase in speed over time), positive pacing (*i.e.* continuous slowing over time), all-out pacing (*i.e.* maximal speed possible, occurring at the start), even pacing (*i.e.* same speed over time), parabolic-shaped pacing (*i.e.* positive and negative pacing in different segments of the race) and variable pacing (*i.e.* pacing with multiple fluctuations). For elite Ironman triathletes of both sexes, a recent study showed that

Ironman triathletes adopt a positive pacing strategy in both the running and the cycling split (Angehrn, Rüst, Nikolaidis, Rosemann, & Knechtle, 2016).

Another important aspect in Ironman triathlon performance is the contribution of swimming, cycling and running to the overall race performance. The three disciplines of triathlon represent distinct locomotion modes with different anthropometric physiological correlates (Bentley, Millet, Vleck, & McNaughton, 2002). Accordingly, a reflection of sex differences in the relative contribution of each discipline to overall performance might be observed, e.g. women spent less relative time (%) in running and more in cycling than men in the 'Ultraman Hawaii' (Knechtle & Nikolaidis, 2016). For the purpose of the present paper, "pacing" refers to the relative contribution of the three disciplines consisting Ironman triathlon to the overall race time. It has been shown that cycling and running presented similar contributions (~40%) for the Ironman distance (Figueiredo, Marques, & Lepers, 2016). These authors analyzed the top 50 overall women and men finishers between 1989 and 2013, and showed that swimming and cycling contributions changed in an undulating fashion, being inverse between the two disciplines (i.e. the higher the performance in swimming, the lower the performance in cycling) for both sexes, while the percentage contribution of running to the overall race time decreased for men. The abovementioned study reported that the overall performance and the absolute times of running and cycling improved across years, whereas the absolute time of swimming remained stable.

Although we know the pacing in cycling and running for elite Ironman triathletes (Angehrn et al., 2016) and the contribution of swimming and cycling to overall Ironman triathlon performance (Figueiredo et al., 2016), we have no knowledge about the pacing of age group athletes (Stiefel, Rüst, Rosemann, & Knechtle, 2013).

Furthermore, a relatively small part of the race is the transition time that might vary by sex and age (Wonerow, Rust, Nikolaidis, Rosemann, & Knechtle, 2017). It is known that pacing strategies during a triathlon race are highly influenced by distance and discipline. For instance, an increase of speed across the race has been reported in the sprint distance run of triathlon, compared with a decrease of speed across the race in the Olympic distance and the half Ironman triathlon (Wu et al., 2015).

However, less information exist about how the pacing varies by the performance level of triathletes. The knowledge of the effect of performance level on pacing would be of great practical value for coaches working with triathletes as it is expected to help them developing optimal pacing strategy and training program. Therefore, the aim of the present study was to examine the effect of performance level on pacing of Ironman triathletes and the role of sex and age. Particularly, we investigated whether slower athletes pace, from one discipline to another, differently compared to faster athletes, and whether transition time varies by performance level.

Materials and Methods

Ethics approval

This study was approved by the Institutional Review Board of Kanton St. Gallen, Switzerland, with a waiver of the requirement for informed consent of the participants as the study involved the analysis of publicly available data.

Data sampling and data analysis

All data were obtained from the official website of Ironman triathlon races (http://eu.ironman.com/events/triathlon-races). Splits and overall race times of women and men professional athletes and age group finishers of all Ironman races were collected. The races were held worldwide between 2002 and 2015. All race times including split and transition times were documented by the official Ironman triathlon website and full data were only available from 2002. Split, transition and overall race times were measured by using an electronic chip system. Before 2002, athletes were not classified in age groups.

Due to missing data or missing age group assignment the data of twelve races could not be gathered. Data from 351,475 athletes competing in 253 different races were considered in the present analysis. Athletes with a transition time faster than 1:02 min:sec (*n*=4,766), whose values were impossible (Rüst, Rosemann, Lepers, & Knechtle, 2014), were excluded from further analysis. Athletes with a transition time slower by three standard deviations (SD) than the mean transition time, *i.e.*>35:18 min:sec (*n*=3,359), were excluded as outliers. Transition times are measured between the swim exit and entering the transition area for the cycling split and again between entering the transition area after cycling and entering the run course. A partial explanation for these high extreme values might be an additional time due to penalties for not conforming to the recommended transition area conduct rules. One case, whose age group was not reported, was also excluded resulting in a final sample of 343,345 athletes.

Statistical analysis

All statistical analyses were performed using the statistical software IBM SPSS v.20.0 (SPSS, Chicago, IL, USA). Descriptive statistics (mean and standard deviation of the mean) were used for all data. The participants were classified into nine performance groups according to their overall race time: <9h, 9-10h, 10-11h, 11-12h, 12-13h, 13-14h, 14-15h, 15-16h, >16h. The rationale for this classification was that an overall race time of 9h is considered as a 'benchmark' performance and 1h 'windows' are used by athletes (Frandsen, Vest, Larsen, Dela, & Helge, 2017). In addition, the participants were classified into 13 age groups (Pro, 18-24 years, 25-29 years, 30-34 years,..., 75-79 years) according to the official website of Ironman (http://eu.ironman.com/events/triathlon-races). Split times in swimming, cycling and running, and time of transition were expressed as percentage of the overall race time. In addition, we used a two-way analysis of variance (ANOVA) with post-hoc Bonferroni test to examine differences in pacing among performance and age groups, and their interaction. The effect size (ES) was examined by eta square (η^2), classified as trivial (η^2<0.01), small (0.01≤ η^2<0.06), medium (0.06≤ η^2<0.14) and large (η^2≥0.14). Sex differences in performance were examined by *t*-test and the effect size of these differences were evaluated by Cohen's d as d≤0.2, trivial; 0.2<d≤0.6, small;

$0.6<d\leq1.2$, moderate; $1.2<d\leq2.0$, large; and $d>2.0$, very large. Statistical significance was set at alpha=0.05.

Results

Men were faster than women for overall race time (small ES), swimming (small ES), cycling (moderate ES) and running (small ES) and transition time (trivial ES) ($p<0.001$) (**Table 1**). Women spent relatively less time in swimming (trivial ES), running (trivial ES) and transition time (trivial ES), and more time in cycling (small ES) ($p<0.001$).

Sex×performance

A trivial sex×performance group interaction on swimming time (%) was observed ($p<0.001$, $\eta^2=0.001$), in which the women fast groups were relatively faster in the swim and the women slow groups were relatively slower than their men counterparts (**Figure 1**). There was a trivial main effect of sex on swim time ($p=0.032$, $\eta^2<0.001$), where women were relatively faster than men (10.13% vs. 10.18%, respectively). Also, there was a small performance group effect on swim time ($p<0.001$, $\eta^2=0.018$), where the slowest performance group was relatively the fastest in swimming.

With regards to cycling time (%), a trivial sex×performance group interaction was shown ($p<0.001$, $\eta^2<0.001$), in which the sex difference was smaller in the fastest performance group. There was a trivial main effect of sex on cycling time ($p<0.001$, $\eta^2=0.003$), where men were relatively faster than women (50.06 vs. 51.30%, respectively). There was a medium main effect of performance group on cycling time ($p<0.001$, $\eta^2=0.138$), where the slowest performance group was the relatively fastest in cycling.

A trivial sex×performance group interaction on running time (%) was observed ($p<0.001$, $\eta^2=0.001$), in which the sex difference was smaller in the fastest performance group. There was a trivial main effect of sex on running time ($p<0.001$, $\eta^2=0.001$), where women were relatively faster than men (36.97 vs. 37.98%, respectively). There was a medium main effect of performance group on running time ($p<0.001$, $\eta^2=0.098$), where the fastest performance group was the relatively fastest in running.

In transition time (%), a trivial sex×performance group interaction was shown ($p<0.001$, $\eta^2=0.001$), in which the sex difference was smaller in the fastest performance group. There was a trivial main effect of sex on transition time ($p<0.001$, $\eta2=0.002$), where women were relatively faster than men (1.59 vs. 1.79%, respectively). There was a large main effect of performance group on transition time ($p<0.001$, $\eta^2=0.178$), where the fastest performance group was the relatively fastest in transition. The overall and discipline times in absolute values by sex and performance group are presented in **Table 2**.

Age group×performance

A trivial main effect of age group on swimming time (%) was observed in women ($p<0.001$, $\eta^2=0.006$) and in men ($p<0.001$, $\eta^2=0.003$), in which the pro and the younger groups spent relatively less time than the older groups did (Figure 2). Also, an age group×performance group interaction on swimming time was shown in women ($p<0.001$, $\eta^2=0.002$) and men ($p<0.001$, $\eta^2=0.001$), in which differences among age groups were larger in the slower performance groups.

In cycling time (%), a trivial main effect of age group was observed in women ($p<0.001$, $\eta^2=0.002$) and in men ($p<0.001$, $\eta^2=0.001$), in which the younger groups spent relatively more time than the older groups did. Also, an age group×performance group interaction on cycling time was shown in women ($p<0.001$, $\eta^2=0.003$) and men ($p<0.001$, $\eta^2=0.002$), in which differences among age groups were larger in the slower performance groups.

A trivial main effect of age group on running time (%) was observed in women ($p<0.001$, $\eta^2=0.001$) and in men ($p<0.001$, $\eta^2<0.001$), in which the younger groups spent relatively less time than the professionals and the older groups did. Also, an age group×performance group interaction on running time was shown in women ($p<0.001$, $\eta^2=0.005$) and men ($p<0.001$, $\eta^2=0.003$), in which differences among age groups were larger in the slower performance groups.

With regards to transition time (%), a trivial main effect of age group was observed in women ($p<0.001$, $\eta^2=0.002$) and in men ($p<0.001$, $\eta^2=0.001$), in which the professionals and the younger groups spent relatively less time than the older groups did. Also, an age group×performance group interaction on transition time was shown in women ($p<0.001$, $\eta^2=0.002$) and men ($p<0.001$, $\eta^2=0.001$), in which differences among age groups were larger in the slower performance groups.

Discussion

The main findings of the present study were that (*i*) women spent relatively less time in swimming, running and transition time, and more time in cycling than men, (*ii*) the slowest performance group was relatively faster in swimming and cycling, whereas the fastest performance group was relatively faster in running and transition time, and (*iii*) the younger age groups were relatively faster in swimming, running and transition time, but relatively slower in cycling.

Sex difference in performance

A first important finding was that women spent relatively less time (%, i.e. they were relatively faster) in swimming, running and transition time, and more time (%, i.e. they were relatively slower) in cycling than men. It should be highlighted that the sex difference in performance either in absolute or relative (%) values was the largest (**Table 1**) for cycling. The relatively slower performance in cycling is most probably due to the lower muscle mass in the legs in women compared to men (Haakonssen, Barras, Burke, Jenkins, & Martin, 2016). On the contrary, the relationship of the transition time with sex was trivial, which indicated that this split time was not influenced by sex differences in performance-related physiological and anthropometric characteristics (O'Toole & Douglas, 1995).

Performance group

A second important finding was that the slowest performance group was relatively faster in swimming and cycling, whereas the fastest performance group was relatively faster in running and the transition time. In other terms, the relatively fastest runners were also the fastest finishers in Ironman triathlons. This finding was in agreement with previous observations in women (Rüst et al., 2012) and men (Rust, Knechtle, Knechtle, Rosemann, & Lepers, 2011) Ironman triathletes, where personal best marathon time was highly predictive for a fast Ironman race time.

In swimming, the fastest women groups were relatively faster and the slowest women groups were relatively slower than their men counterparts. This finding is different compared to shorter distances. The split time of swimming seems to correlate positively with overall race time of the short races, which is not true for longer races (Pacheco, dos Santos Leite, de Lucas, & Guglielmo, 2012). A very fast start during the 1,500 m of an Olympic distance triathlon is paramount for overall race time, whereas in Ironman distance triathlon, an even pace is recommended for energy sparing (Millet, Vleck, & Bentley, 2011). Overall, the swim section strongly influences the subsequent cycling and running sections in triathlon (Millet et al., 2011). It has been shown that a relatively slow swimming intensity might result in faster cycling and overall triathlon performance (Peeling, Bishop, & Landers, 2005); on the other hand, a relatively fast swimming would induce higher plasma lactate concentration, which, in turn, would increase fatigue and decrease performance in the following disciplines. Furthermore, it was observed that the SD for all disciplines and transition was smaller in the fast performance groups compared to their slow peers indicating that the former consisted in a more homogeneous group than the latter. With regards to disciplines, it was observed that swimming was more heterogeneous than running and cycling highlighting the key role of swimming performance in Ironman triathlon.

In Olympic distance triathlon, women and men elite triathletes adopted similar pacing strategies during swimming and running disciplines, where their speed was decreasing during these disciplines. Men adopted a more even pace during the swim-to-cycle transition contrary to the women, who were more affected by changes in slope during the cycling and running phases (Le Meur et al., 2009). It appears that inferior swimming performance in Olympic distance triathlon can result in a tactic that involves greater work in the initial stages of the cycle stage of elite athletes and may influence subsequent running performance (Vleck, Bürgi, & Bentley, 2006).

The slowest performance group was relatively the fastest in cycling. In other terms, athletes who went fast in the bike split decreased largely their speed in the following discipline (running). This trend might represent a pacing strategy that is typical for the slowest athletes of endurance and ultra-endurance sports (e.g. marathon running and cross-country skiing), according to which these athletes decrease their speed to a greater extend across the race compared to their faster counterparts (Nikolaidis & Knechtle, 2018; Nikolaidis, Villiger, Rosemann, & Knechtle, 2018). Considering these differences, slow athletes cycled relatively fast resulting in relatively more fatigue from cycling, which might impair their subsequent performance in running. This might explain the opposite trends observed for cycling and running with regards to the fast performance groups.

In running, the fastest performance group was relatively the fastest highlighting the importance of this discipline for the overall performance in an Ironman triathlon. The role of the running discipline varies depending upon the length of the race distance, e.g. it is less important (in terms of its overall percentage contribution to the overall race time) in Ironman triathlon compared to Olympic distance triathlon (Figueiredo et al., 2016). A similar contribution of running and cycling disciplines (~40% each) has been observed in an Ironman triathlon, whereas their contribution was ~47% and 36%, respectively in the Olympic distance triathlon (Figueiredo et al., 2016). In Olympic distance triathlon, performance (*i.e.* rank and velocity) in the running discipline was highly correlated with overall race result (Vleck et al., 2006) and pacing during the run appears to play a key role in high-level triathlon performance (Le Meur et al., 2011). There also seems to be a difference between women and men for the importance of the running section in Olympic distance triathlon. In Olympic distance triathlon, average run speed correlated better with finishing position in men than women (Vleck et al., 2006). Strategies to improve running performance should be the main focus on the preparation to compete in the Olympic distance whereas in the Ironman both cycling and running are decisive and should be well developed (Figueiredo et al., 2016). Regarding transition times, the fastest performance group in the present study was relatively the fastest in transition times. Transition times seemed to be dependent upon the length of a triathlon race. Generally, transition times were slower in 'Ironman Hawaii' compared to 'Ironman 70.3' (Rüst et al., 2014).

Age group

A third important finding was that the younger age groups were relatively faster in swimming, running and transition time, but relatively slower in cycling than their older counterparts. An explanation of this trend might be the age-related differences in these three locomotion modes in Ironman triathletes. For instance, it has been shown previously that performance declines earlier in swimming than in cycling, running, and overall race time (Kach, Rust, Nikolaidis, Rosemann, & Knechtle, 2018). The different relative contribution of disciplines to the overall Ironman race time among age groups indicates a different distribution of effort during the race depending on athletes' age. This finding is in agreement with studies on other endurance - such as marathon running (Nikolaidis & Knechtle, 2018) - and ultra-endurance sports - such as cross-country skiing (Nikolaidis et al., 2018) - that recorded different pacing strategies between age groups, where older age groups adopted a more even pacing than the younger age groups.

Limitations, strength and practical applications

We are aware of some limitations of this cross-sectional retrospective data analysis. In this type of study, individual factors of endurance performance such as anthropometric (Hoffman, 2008; Knechtle, Knechtle, Christoph, & Rosemann, 2011) and demographic characteristics (Hoffman & Fogard, 2012), as well as training regimes (Gulbin & Gaffney, 1999; Knechtle et al., 2011; Knechtle, Wirth, Baumann, Knechtle, & Rosemann, 2010), motivation (Hodge, Allen, & Smellie, 2008; Houston, Dolan, & Martin, 2011; Krouse, Ransdell, Lucas, & Pritchard, 2011) and previous race experience (Knechtle et al., 2010) could not be taken into consideration. Other aspects that were not controlled in our analysis were nutrition (Costa, Hoffman, & Stellingwerff, 2018), hydration (Hoffman, Stellingwerff, & Costa, 2018), sleeping habits (Hurdiel et al., 2018) and substance use (Didier et al., 2017). Additionally, the comparability of performances between different triathlon races might be limited due to the differing race courses and weather conditions (Rüst et al., 2012). For instance, a recent study on the 'Boston Marathon' from 1897 to 2017 suggested that a temperature lower than 8°C and a precipitation higher than zero would improve race performance (Knechtle, Di Gangi, Rüst, Rosemann, & Nikolaidis, 2018). A further limitation was that 8,125 athletes had to be excluded due to impossible or unreliable transition times. Although transition times are only ~5-6 min of overall race time (~1% of overall race time) they should not be ignored since they increased in recent years in 'Ironman Hawaii' (Rüst, Rosemann, Lepers, & Knechtle, 2014). However, the excluded sample of 8,125 athletes was only ~2% of the whole sample.

On the other hand, a strength of this study was the large volume of data examined, which allowed detecting even very small differences among performance and age groups, and the practical implications of the findings. For athletes and coaches, the fastest Ironman triathletes are the relatively fastest in running and transition times, whereas the slowest athletes were the relatively fastest in swimming and cycling. For practical applications, race tactics in an Ironman triathlon should focus on saving energy during swimming and cycling for running a fast marathon at the end of the race. In addition, the data presented in **Table 2** can be used as an informative guide for Ironman athletes in order to set discipline-specific training goals according to sex and performance level, and distribute the training volume to swimming, cycling and running, accordingly.

Conclusions

In summary, we found differences by sex and age group regarding pacing in Ironman triathletes. Women in contrast to men spent relatively less time (%) in swimming, running and transition time, and relatively more time (%) in cycling. Athletes in the slowest performance group were relatively faster in swimming and cycling, whereas athletes in the fastest performance group were relatively faster in running and transition time. Finally, athletes in the younger age groups were relatively faster in swimming, running and transition time, but relatively slower in cycling.

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Table 1 Sex differences in overall race time, swimming, cycling, running and transition time in absolute and relative (percentage of the overall race time) values

		Women (n=69,060)	Men (n=274,285)	Cohen's d
Swimming	h:min:sec	1:20:49 (0:14:21)	1:16:18 (0:13:45)	0.30
	%	10.13 (1.35)	10.26 (1.38)	–0.10
Cycling	h:min:sec	6:42:45 (0:47:35)	6:10:49 (0:47:06)	0.68
	%	50.55 (2.83)	49.88 (3.05)	0.23
Running	h:min:sec	5:01:20 (0:54:33)	4:45:19 (0:56:48)	0.29
	%	37.53 (3.01)	38.01 (3.34)	–0.15
Transition time	h:min:sec	0:14:38 (0:06:18)	0:14:08 (0:06:15)	0.08
	%	1.79 (0.61)	1.84 (0.65)	–0.08
Overall race time	h:min:sec	13:19:32 (1:46:00)	12:26:34 (1:47:14)	0.50

* Data are presented as means with standard deviations in brackets. All comparisons between sexes showed differences at p<0.001.

Table 2 Overall race time, swimming, cycling, running and transition time in absolute values (h:min:sec) by sex and performance group.

	Performance group								
	<9h	9-10h	10-11h	11-12h	12-13h	13-14h	14-15h	15-16h	>16h
Women									
Swimming	0:53:53±0:04:01	0:59:20±0:06:04	1:06:04±0:07:14	1:11:55±0:08:31	1:17:02±0:09:54	1:22:04±0:11:11	1:26:39±0:12:30	1:31:34±0:13:45	1:37:02±0:14:31
Cycling	4:51:21±0:06:50	5:11:56±0:11:40	5:35:48±0:13:40	5:59:00±0:16:34	6:23:30±0:19:27	6:47:57±0:22:35	7:11:43±0:24:55	7:34:27±0:26:25	7:58:11±0:25:31
Running	3:03:15±0:06:11	3:21:03±0:10:53	3:46:14±0:14:05	4:11:49±0:17:49	4:37:59±0:22:08	5:04:54±0:25:38	5:33:25±0:28:32	6:03:27±0:29:55	6:31:00±0:25:58
Transition	0:04:41±0:00:47	0:05:23±0:01:27	0:07:23±0:02:11	0:09:49±0:02:58	0:12:50±0:03:58	0:15:45±0:04:41	0:17:59±0:05:05	0:19:53±0:05:18	0:20:43±0:05:24
Overall	8:53:11±0:05:55	9:37:43±0:15:45	10:35:30±0:16:51	11:32:34±0:17:01	12:31:22±0:17:11	13:30:41±0:17:14	14:29:48±0:17:08	15:29:22±0:17:13	16:26:56±0:16:18
Men									
Swimming	0:53:10±0:04:46	1:01:26±0:06:18	1:07:00±0:07:36	1:12:14±0:09:04	1:17:00±0:10:29	1:21:36±0:11:46	1:26:02±0:13:09	1:30:43±0:14:24	1:36:01±0:15:29
Cycling	4:41:34±0:10:07	5:05:14±0:11:38	5:26:24±0:14:28	5:49:07±0:18:04	6:12:13±0:21:40	6:35:32±0:25:09	6:58:47±0:28:17	7:22:48±0:30:25	7:47:08±0:30:24
Running	3:01:20±0:09:10	3:25:01±0:12:24	3:50:51±0:16:27	4:18:50±0:20:55	4:46:56±0:25:30	5:15:19±0:29:29	5:44:45±0:32:57	6:14:00±0:34:41	6:40:26±0:32:13
Transition	0:04:43±0:01:22	0:06:47±0:01:55	0:08:54±0:02:42	0:11:45±0:03:43	0:14:41±0:04:31	0:17:22±0:05:08	0:19:36±0:05:30	0:21:23±0:05:33	0:22:20±0:05:34
Overall	8:40:49±0:14:31	9:38:29±0:15:42	10:33:11±0:16:55	11:31:57±0:16:59	12:30:52±0:16:58	13:29:50±0:17:02	14:29:13±0:17:01	15:28:54±0:17:04	16:25:57±0:16:04

* Data are presented as means±standard deviations.

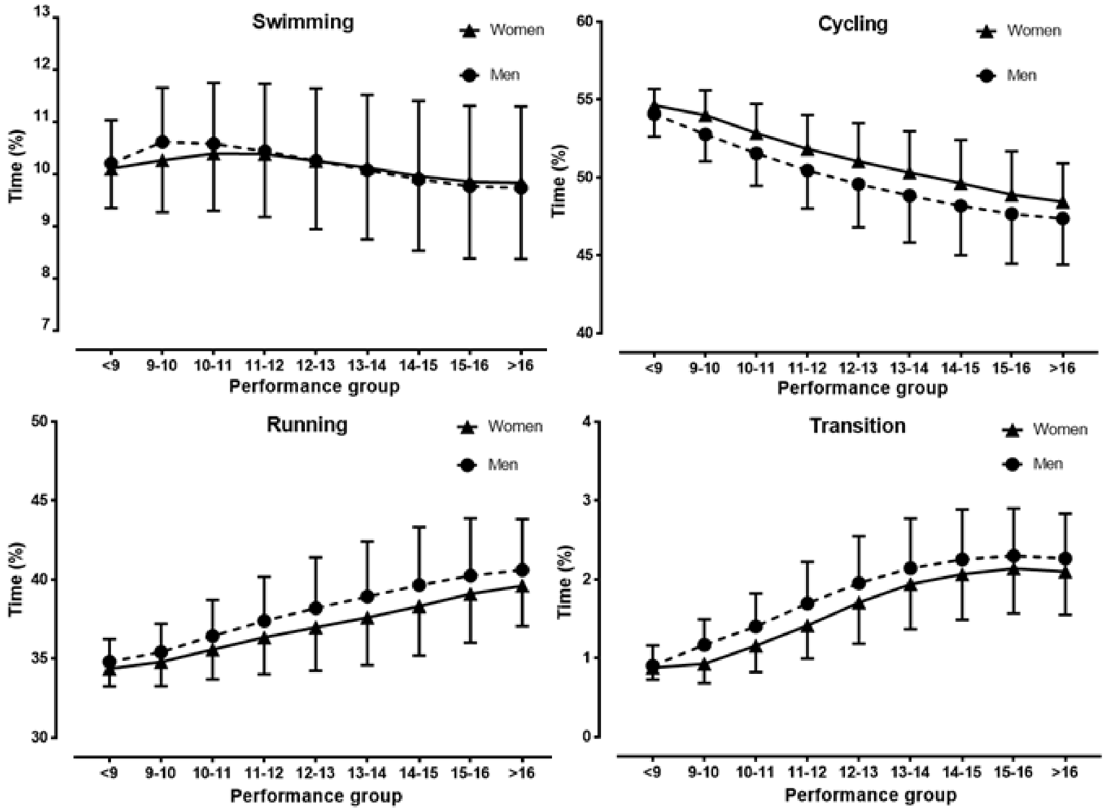
Legends of figures

Figure 1 Relative times of swimming, cycling, running and transition expressed as percentage of the total race time by sex and performance group. Error bars represent standard deviations.

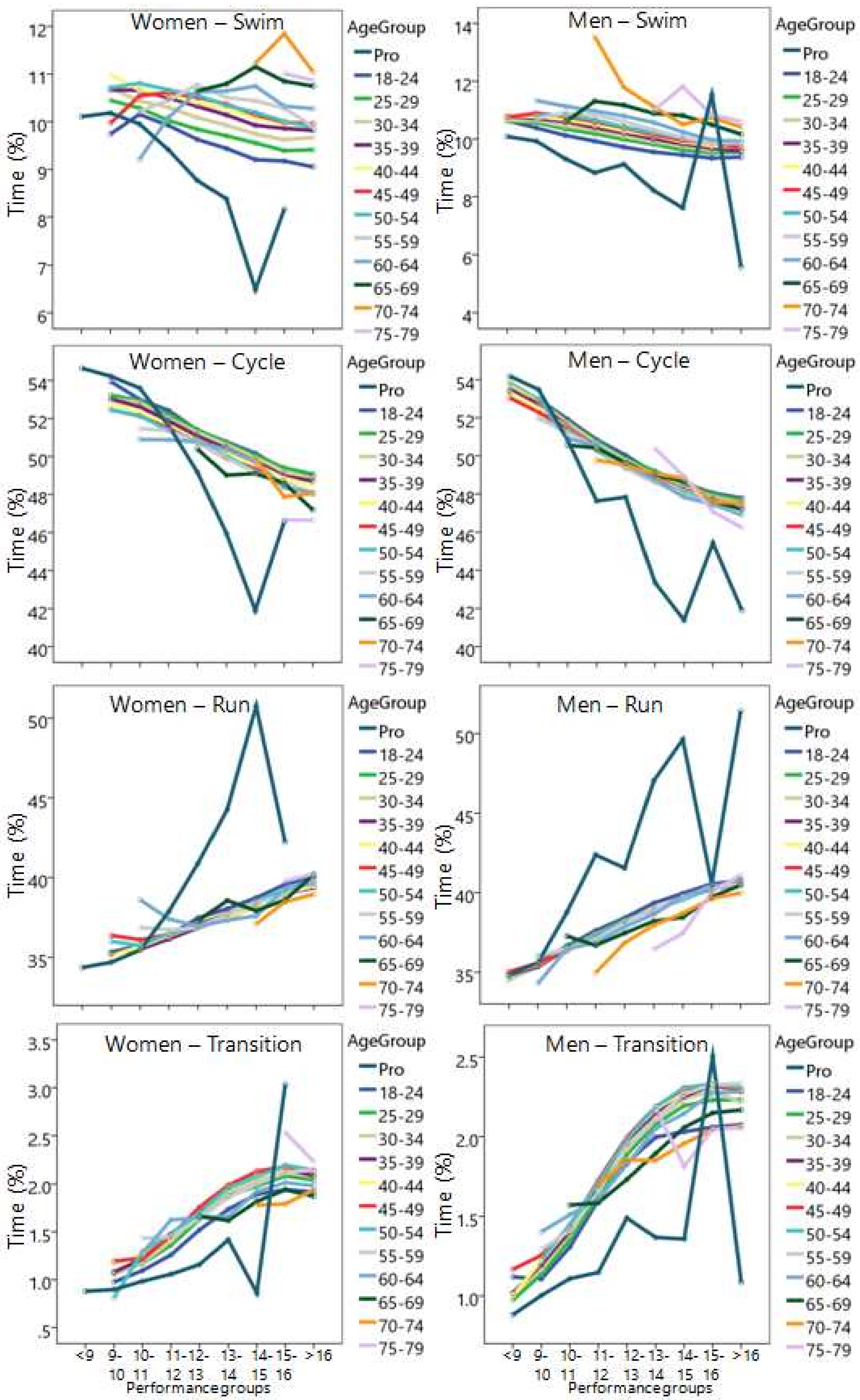
Figure 2 Relative times of swimming, cycling, running and transition expressed as percentage of the total race time by age group in women and men.

Lines do not cover all the span of performance groups due to the relatively slow times of the older age groups, i.e. the frequency of the older age groups in the faster performance groups is zero.

Figure 1


Swimming
Cycling
Running
Transition
Women
Men
Time (%)
Performance group
<9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
>16

1 **Figure 2**


Women – Swim
Men – Swim
Women – Cycle
Men – Cycle
Women – Run
Men – Run
Women – Transition
Men – Transition
Time (%)
Performancegroups
AgeGroup
Pro
18-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
<9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
>16

2